

- which, upon the foam precursor attaining the appropriate expansion temperature, contains the expanding carbon to some predetermined configuration such as: a flat sheet; a curved sheet; a shaped object; a building block; a rod; tube or any other desired solid shape can be considered a "mold" for purposes of the instant
- 5 invention. The term "mold" as used herein, is also meant to include any container, even an open topped container that "contains" the expanding mixture so long as such a device is contained in a pressurizable vessel that will permit controlled foaming as described herein. Clearly, a container that results in the production of some particular near net or net shape is particularly preferred.
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- As will be apparent to the skilled artisan familiar with pressurized gas release reactions, as the pressure in the reaction vessel, in this case the mold increases, from 0 psi to 500 psi, as imposed by the inert or non-oxidizing gas, the reaction time will increase and the density of the produced porous coal will increase
- 15 as the size of the "bubbles" or pores produced in the expanded carbon decreases. Similarly, a low soak temperature at, for example about 400°C will result in a larger pore or bubble size and consequently a less dense expanded coal than would be achieved with a soak temperature of about 600°C. Further, the heat-up rate will also affect pore size, a faster heat-up rate resulting in a smaller pore size and
- 20 consequently a denser expanded coal product than a slow heat-up rate. These phenomenon are, of course, due to the kinetics of the volatile release reactions which are affected, as just described, by the ambient pressure and temperature and the rate at which that temperature is achieved. These process variables can be used to

custom produce the expanded coals of the present invention in a wide variety of controlled densities, strengths etc.

Cooling of the “green foam” after soaking is not particularly critical except

- 5 as it may result in cracking of thereof as the result of the development of undesirable thermal stresses. Cooling rates less than 10° C/min to a temperature of about 100° C are typically used to prevent cracking due to thermal shock.

Somewhat higher, but carefully controlled, cooling rates may however, be used to obtain a “sealed skin” on the open cell structure of the product as described below.

- 10 The rate of cooling below 100° C is in no way critical.

After expanding the carbon material as just described, the “green foam” is an open celled material. Several techniques have been developed for selectively “sealing” the surface of the open celled structure to improve its adhesive capabilities

- 15 for further fabrication and assembly of a number of parts. For example, a layer of a commercially available graphitic adhesive (for example an epoxy-graphite adhesive) can be coated onto portions of the surface and cured at elevated temperature or allowed to cure at room temperature to provide an adherent skin

- 20 After expanding, the “green foam” is readily machineable, sawable and otherwise readily fabricated using conventional fabrication techniques.

A variety of additives and structural reinforcers may be added to the carbon materials of the present invention either before or after expansion to enhance specific mechanical properties such as fracture strain, fracture toughness and impact resistance. For example, particles, whiskers, fibers, plates, etc. of

- 5 appropriate carbonaceous or ceramic composition can be incorporated into the abrasive foam to enhance its mechanical properties.**

The activated foams of the present invention can additionally be impregnated with; for example, petroleum pitch, epoxy resins or other polymers using a vacuum assisted resin transfer type of process. The incorporation of such additives provides load transfer advantages similar to those demonstrated in carbon composite materials. In effect a 3-D composite is produced that demonstrates enhanced impact resistance and load transfer properties.

- 15 The cooling step in the expansion process results in some relatively minimal shrinkage on the order of less than about 5% and generally in the range of from about 2% to about 3%. This shrinkage must be accounted for in the production of near net shape or final products of specific dimensions and is readily determinable through trial and error with the particular carbon starting material being used.**

- 20 The shrinkage may be further minimized by the addition of some inert solid material such as coke particles, ceramic particles, ground waste from the coal expansion process etc. as is common practice in ceramic fabrication.**